Through School To Nation

Changkat Changi Secondary School

UNIT 1

Measurement

Name: _____

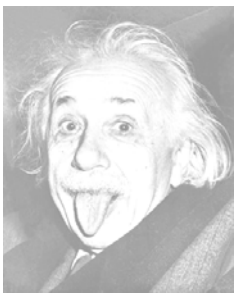
Class: _____

Date: _____

CONTENT PAGE

"The whole of science is nothing more than a refinement of everyday thinking."

---Albert Einstein



NOTES 1.1

LESSON OBJECTIVES

At the end of the lesson, you will be able to:

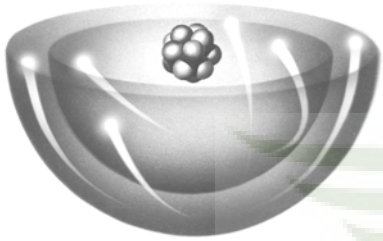
- understand that all physical quantities consist of a numerical magnitude and a unit
- recall the seven base quantities and their units
- use prefixes and symbols to indicate very big or very small SI quantities

WHAT IS PHYSICS?

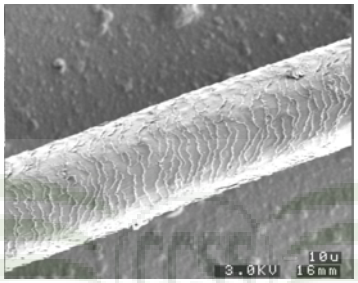
Physics is the scientific study of matter and energy and how they interact with each other. This energy can take the form of motion, light, electricity, radiation, gravity . . . just about anything.

Physics deals with matter on scales ranging from sub-atomic particles (i.e. the particles that make up the atom and the particles that make up those particles) to stars and even entire galaxies.

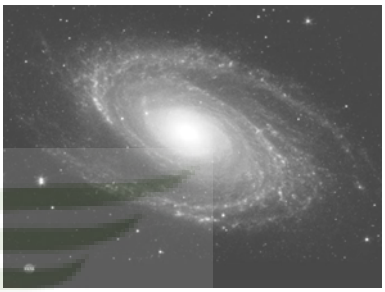
Can you recognise the matter below? What are their sizes?



Atom --the radii of isolated n



Hair-- diameter of appro›



Galaxies

PHYSICAL QUANTITIES

A physical quantity refers to a quantity that can be measured and is written with a magnitude and unit. Find out and fill in the measurements for the objects given in the table below.

Physical Quantities	Magnitude (size)	Name of Unit	Symbol for unit
Your mass in kilograms	80 kg	kilogram	kg
Length of your index finger	7 cm	centimetre	cm
Your reaction time	0.2 to 0.3s	seconds	s

SI units (*le **S**ystème **i**nternational d'unités)*

To standardize the units used for measurements, an internationally system of units for basic physical quantities known as S.I. units were defined. 7 key quantities shown in the table below:

Basic physical quantity	Name of unit	Symbol for unit
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

DERIVED PHYSICAL QUANTITIES

Other physical quantities such as area or volume of an object are called **derived** quantities because they have units derived from the basic physical quantities.

Try it! Which are the units for the derived quantities shown below?
(First one done for you)

Derived quantity	Basic quantities used	Symbol for unit
Area	Length x length	m^2
Volume	Length x length x length	m3
Speed	Length/time	m/s
Rate of change in volume	(Length x length x length) / time	m3/s
Density	Mass/ (Length x length x length)	kg/m3

PREFIXES

In order to simplify writing of quantities which have very large numerical values or very small numerical values, prefixes are used. Prefixes basically represent factors of tens.
A table of these prefixes is shown below:

Prefix	**Abbreviation**	**Factor**	**Meaning**
giga-	G	10^9	1000 000 000
mega	M	10^6	1000 000
kilo	K	10^3	1000
deci	d	10^{-1}	1/10 or 0.1
centi	c	10^{-2}	1/ 100 or 0.01
milli	m	10^{-3}	0.001
micro	µ	10^{-6}	0.000001
nano	n	10^{-9}	0.000000001

Also, check out this video on Prefixes-Powers of ten:
http://www.youtube.com/watch?v=0fKBhvDjuy0 or
http://www.youtube.com/watch?v=aPm3QVKlBJg&feature=related

Can you think of a way to help you remember the prefixes?

NOTES 1.2

LESSON OBJECTIVES

At the end of the lesson, you will be able to:

- have a good sense of the orders of magnitude
- describe how to measure a variety of lengths using the appropriate instruments (e.g. metre rule, vernier calipers, micrometer)
- Use a vernier scale

MEASURING LENGTHS

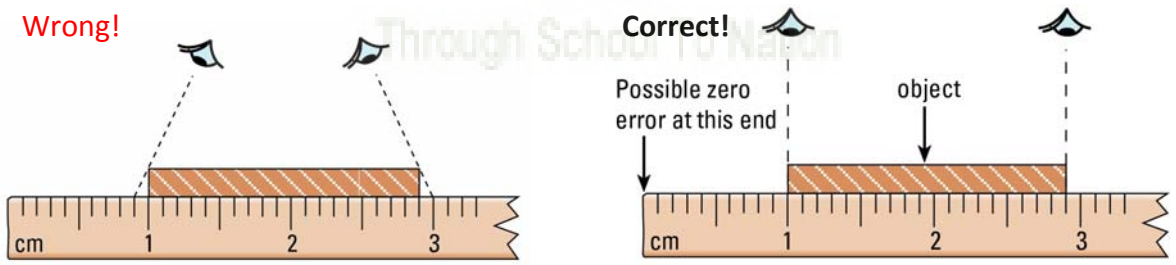
There is a wide range of lengths in this world, hence requiring a variety of instruments to make accurate measurements. For each instrument, they have a specific precision level that allows them to measure certain objects. Table below summarizes the instruments to be discussed in this unit.

Length measuring Instrument	Example of readings	Precision (Smallest unit it can measure)	Maximum reading
15 cm ruler	10.3 cm, 12.5 cm	0.1 cm	15.0 cm
Metre rule	25.6 cm, 41.5 cm	0.1 cm	100.0 cm
Vernier caliper	5.05 cm,6.02 cm	0.01 cm	15.00 cm
Micrometer screw gauge	1.25 mm, 2.10mm	0.01 mm	25.00 mm

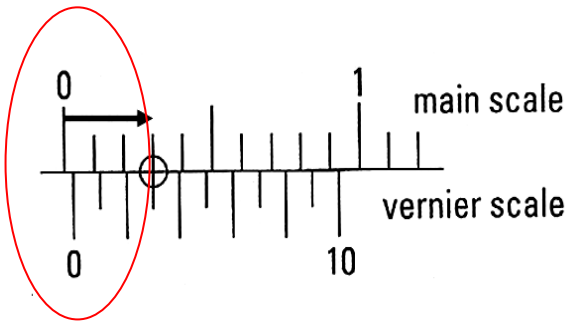
BEFORE YOU MAKE A MEASUREMENT….

Always take note of these:

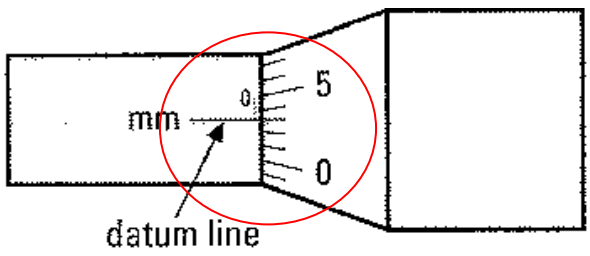
(A) Parallax errors—Placing the eye at the wrong position



(B) Zero errors – when the zero on the main scale and the zero on vernier scale do not meet.



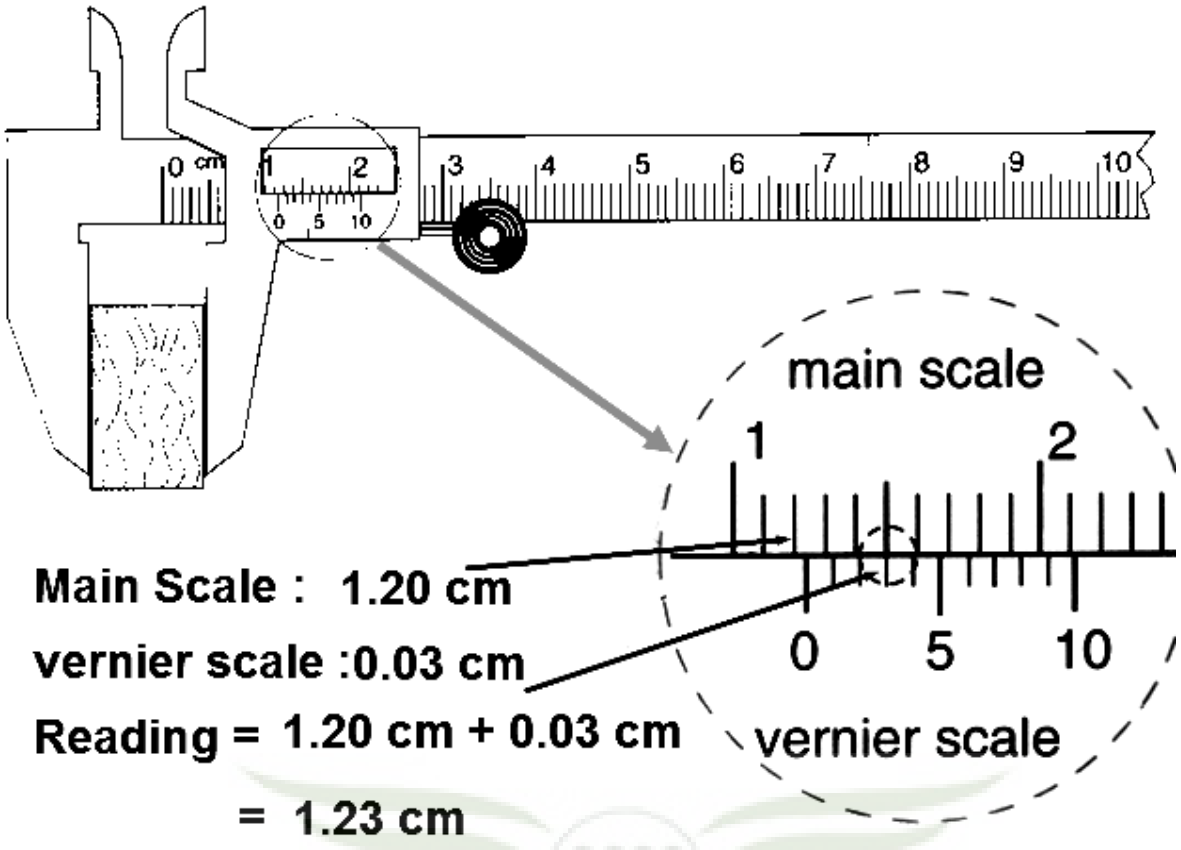
Zero error on Vernier Calipers



Zero error on micrometer

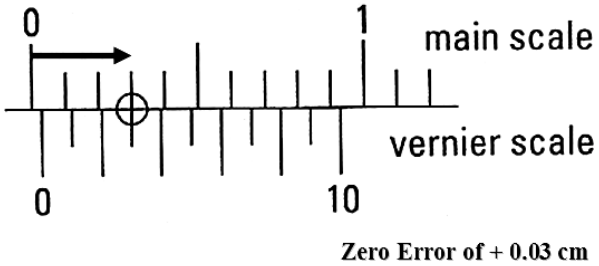
TRY IT! ***Practical 1-- Measuring objects using vernier calipers and micrometer screw gauge***

READING VERNIER CALIPER—AN EXAMPLE



CORRECTING ZERO ERRORS ON VERNIER CALIPERS

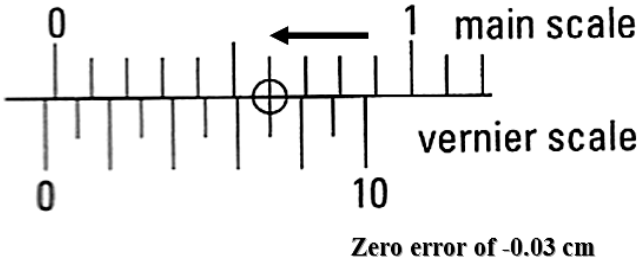
Positive error



Zero Error of + 0.03 cm

Reading from measurement = 1.23 cm
Corrected reading
= 1.23 – (+0.03)
= 1.20 cm

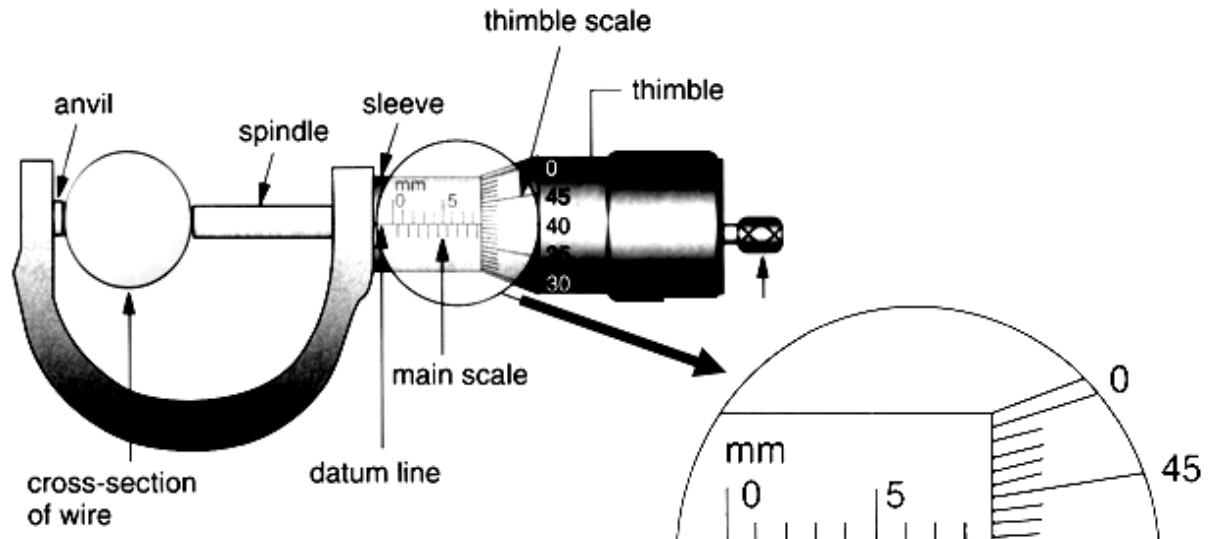
Negative error

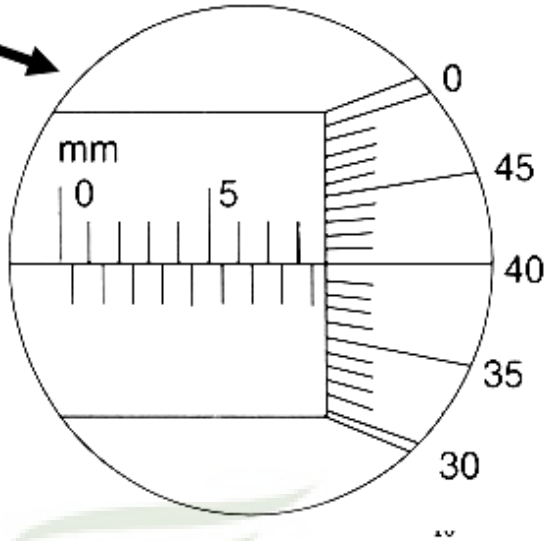


Zero error of -0.03 cm

Reading from measurement = 1.23 cm
Corrected reading
= 1.23 – (-0.03)
= 1.26 cm

READING MICROMETER SCREW GAUGE—AN EXAMPLE





Main reading : 8.5 mm

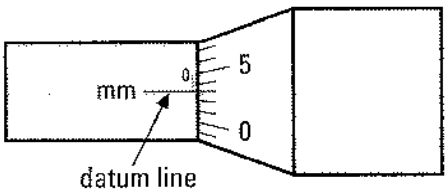
Thimble reading: 0.40 mm

Reading = 8.5 mm + 0.40 mm

= 8.90 mm

CORRECTING ZERO ERRORS ON MICROMETER SCREW GAUGE

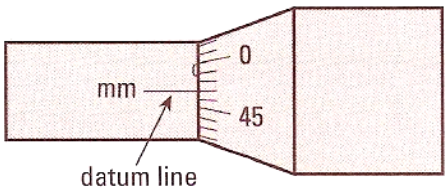
Positive error



Zero mark on datum line to the left:
a **positive zero error** of +0.03 mm.

Reading from measurement = 8.90mm
Corrected reading
= 8.90 – (+0.03)
= 8.87 mm

Negative error



Zero mark on datum line to the right:
a **negative zero error** of –0.03 mm.

Reading from measurement = 8.90mm
Corrected reading
= 8.90– (-0.03)
= 8.93 mm

NOTES 1.3

LESSON OBJECTIVES

At the end of the lesson, you will be able to:

- Describe how to measure periods of time using the pendulum, stopwatch and other appropriate instruments.

Measuring time

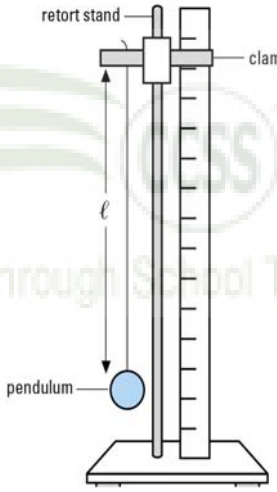
There are many ways which time can be measured, ranging from a sun dial to a digital watch. Each has its own precision and all use some kind of periodic motion to tell the time. Digital stop watch has a precision of up to 0.01 s.

THE PENDULUM

On earth, it is found that the repeating swinging of a pendulum was dependent on its length. Hence, by adjusting its length, pendulum clocks can be calibrated to measure seconds, minutes and hours.

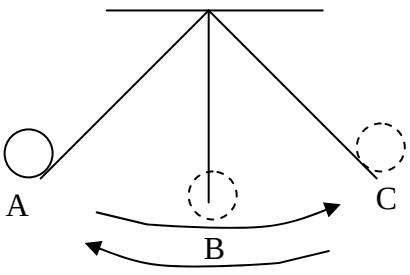
SETTING UP A PENDULUM

The figure below shows how a pendulum is set up with a retort stand, a bob, string and clamp.



The pendulum is displaced to one end and allowed to swing until it comes to a stop. During this time, a stop watch is used to time the swinging motion.

Each complete swinging motion of the pendulum (see below) is termed the **Oscillation**.



One oscillation can mean swing from position

i) A to C to A **or**

ii) B to C to A to B

iii) C to A to C

Time taken for the pendulum to make one complete oscillation is termed the **Period**, represented by letter **T**.

WHAT AFFECTS THE PERIOD OF PENDULUM?

TRY IT! ***Practical 2-- Pendulum Experiment***

From practical 2, you are to investigate how length affects the period of swing. Describe how it affects the period. Can you think of another variable that affects the period?

When the length of pendulum is increased, period of swing increased and vice versa.

Gravitational field also affects the period -- a lower gravitational field will increase the period of swing

Mass has no effect on the period

Variables affecting period of pendulum (verified by scientists) as described in a formula:

PRECAUTIONS IN PENDULUM EXPERIMENT

1. To minimise timing errors, 20 oscillations of a pendulum are usually used to determine the average time for 1 oscillation.

2. The pendulum is left to swing for 5 to 10 oscillations before timing to allow the pendulum swings to stabilize.

3. Ensure the pendulum swing in its plane and not in an elliptical path.

4. Ensure the angle of swing is within 5 to 10 degrees.

SOURCE OF ERRORS

1. Human reaction time (of 0.3s) causes error in the experiment as the exact timing of swings cannot be obtained.

2. The extension of the string due to weight of bob can also affect the period as the length would vary.